NY Energy Highway RFI

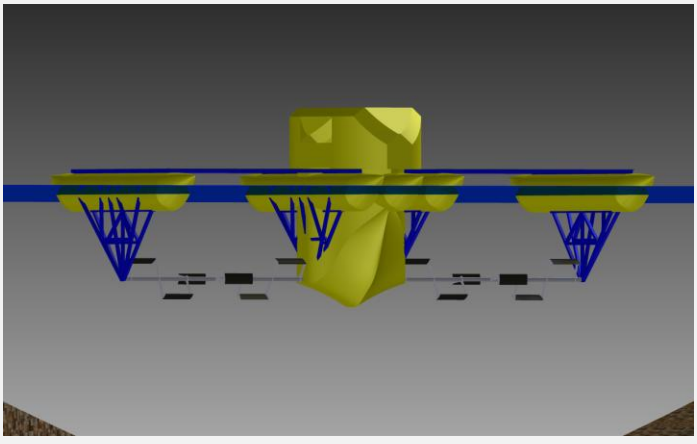
Marine Hydro Kinetic Commercial Technology Project

Fisher's Island, NY 10 MW

NYS Canal Systems & Mohawk Valley 10 MW

Natural Currents Energy Services, LLC.

May 30, 2012



I. Respondent Information

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e. Brief Bio

Roger Bason Bio - **Roger Bason**, President and Founder of Natural Currents, has directed over twenty significant tidal energy technology related projects over the past ten years. He has initiated and developed innovative approaches for in-stream hydroelectric project systems analysis, site evaluation, component construction, field-testing, performance and marine impact analysis and permitting for projects proposed in five states including Alaska, Washington, New York, New Jersey and Massachusetts. Bason has served as Adjunct Professor at the School of International Public Affairs (SIPA) Center for Energy, Marine Transportation and Public Policy at Columbia University (2002 – 2004) where he taught interdisciplinary graduate workshops in tidal energy.

He has directed intern programs in the practical study of tidal energy for students from 14 colleges and universities including Columbia, Vassar, Bard, SUNY Maritime, SUNY New Paltz, MIT, USC, Penn State and others. He is a leader in the field of sustainable development and has served as president of the Institute for a Sustainable Future while directing the Hawaii Ameri-Corps program from 1995 - 1996. Bason is an advisor to the Partnership for Small Island Developing States at the United Nations. He has provided expert consultation to the Long Island Power Authority, US Job Corps and the New and Renewable Energy Centre (NaREC) in Blythe, Northampton, UK, a leader in the ocean energy field.

Recent work includes tidal site assessments for the Duchy of Cornwall on the rivers Tamar and Dart in SW England. Bason directs the development of a Renewable Energy Park facility (wind-solar-tidal demonstration) in coordination with the NYC Parks Department and the US DOE scheduled for completion in 2014. This project includes the installation of wind, solar and tidal electric equipment for public education, training and research on environmental impacts on the East River in the heart of NYC.

Fig-1. Testing NC Dragon Fly 10 kW Tidal Turbine.

Fig-2. NC Tidal Energy Site, Hell Gate, East River, NY

II. Project Description

a. Type of Project - Marine Hydro Kinetic (MHK) Power Generation
   i. Fishers Island, New York – Tidal Energy Project
   ii. NYS Barge Canal - Mohawk Valley MHK Project
b. Project Size
   i. Fishers Island Tidal Energy Project – 10 MW
   ii. Mohawk Valley MHK Project – 10 MW
c. Proposed Location
   i. Fishers Island, New York – Off shore in The Race waterway
   ii. Mohawk Valley – 14 locations between Little Falls, NY and Albany, NY
d. Fuel Source
   i. Fishers Island – Tidal Flow in The Race
   ii. Mohawk Valley – Locks, Bridges and Barge Canal Water Flows
e. Earliest Date Operational
   i. Fishers Island – 2014 – First Units Installed with expedited regulatory review
   ii. Mohawk Valley – 2014 – First Units Installed with expedited regulatory review
f. Experience with Project Technology

Natural Currents (NC) proposes two 10 MW projects to provide commercial grade MHK power to two regions in NYS. The Mohawk Valley site proposes to install 10 MW of MHK along a six county region in central NYS along flowing waters within the New York State Canal System. The second site encompasses the off shore region adjacent to Fishers Island in The Race at the end of Long Island Sound. Preliminary Permits Applications have been made to the Federal Energy Regulatory Commission (FERC) for both locations by Natural Currents Energy Services, LLC.

NC has developed three tidal energy systems at various stages of development: 10 kW, 100 kW and a pilot scale Red Hawk system (20 kW, scalable to 1,000 kW). The 100 kW NC Sea Dragon will be the go to unit for the proposed installations.

The design team has completed tests including the following component evaluations in the NIIES Scientific Research Institute (2009) and the TZAGI T-2 Wind Tunnel (2010) in Moscow with water flume testing connected at Alden Labs in Holden, Massachusetts, USA (2008). The flume testing resulted in a substantial redesign of the system and additional component testing of redesigned elements. System component testing has included successful evaluation and design for (1) Blades: [a] Number of blades in rotors, [b] Angle of blades to tangent optimization, [c] RPM evaluation based on various blade conditions, [d] U/V tip speed ratio analysis, [e] Blade length performance analysis, [f] Optimizing Blade chord, [g] Blade profile optimization. [h] Physical testing for elasticity, shearing, tensile, compression strength. 2) Generator: [a] Inductor placement, [b] Inductor structure and windings, 3) Control Scheme: [a] Power conditioning equipment selection.

III. Project will address the NYS Energy Highway Goals and Objectives as follows:

New York State is richly endowed with abundant hydropower resources that currently provide approximately 18% of the states electricity generation[1], most of which comes from two hydropower facilities (2300 MW) at Niagara Falls. While this is a significant achievement for NYS, there are many additional untapped hydropower resources that are ignored or underutilized. Cutting edge technology in the field of Marine Hydro Kinetic (MHK) power generation enables a future of distributed generation of hydropower using flexibly deployed MHK turbines that can provide widespread economic stimulus in the form of energy savings, job growth and manufacturing revenues. NC has been a leader in the field of MHK technology development.

With the support of the USDOE, knowledge gained from the Wards Island Tidal Demonstration Project begun in 2012 will contribute benefits to diverse regions throughout New York State. The proposed projects will use these Wards Island project findings to establish standard methods for system installation, component performance, maintenance, reporting, environmental monitoring and financial cost. These proposed initial projects can eventually benefit regions including communities along upstate New York rivers as well as parts of the extensive 534-mile (860 km) NYS canal system and selected locations along the 1,850 miles (2977 km) of NYS tidal shoreline[2].

Many cooperating strategic partners engaged in the planning and development of this project include the engineering team at **FALA, Inc** located in Kingston, New York providing system manufacture. **George G. Sharp, Inc** has completed the innovative vessel based deployment design. Sharp is the oldest naval architecture company in the US and is located near Ground Zero in New York City. **Natural Currents** has completed system testing and will provide the commercial grade tidal electric turbine. **Northstar Marine Services, Inc** will manage the installation at the permitted site on the south shore of Wards Island in the heart of New York City. The Monitoring Team includes **Innovation Engineering** to evaluate system power output with consulting support from the Cornell BioAcoustics. **Environmental Research and Consulting, Inc** (ERC) will perform the studies and environmental monitoring of the site. Operations and maintenance are the responsibility of Natural Currents.

New York State downstream supply chain can contribute significantly and also benefit financially from the manufacture of system components. Energy benefits will flow to appropriate state facilities and agencies, municipalities, counties, and NYS manufacturing associations from either clean energy generation, jobs generation or manufacturing revenue. Benefits include significant technical performance knowledge of MHK systems, and feedback on system operations. Economic benefits include manufacturing revenue, energy savings and job creation. The proposed project forms the basis of improved public education, technology demonstration and provides a training site location for future workers in this emerging field from New York Academic Institutions.

Opportunity. New York State has abundant and underutilized kinetic hydropower resources that will have a more direct and rapid path to commercial development with the success of the proposed Tidal Demonstration Projects. The aggressive goals of the NYS RPS standards will be easier met with the added clean power benefits of similar systems that are installed throughout the flowing waterways of the state.

- There is an alarming and significant need for economic stimulus in Upstate New York. The 50 Upstate NY counties rank 48th of 50 states in personal income. Population growth for the region is 51st in the US behind all states and the District of Columbia.[3] The proposed demonstration project can have significant benefits from energy revenues and jobs from the replication of the project in update regions. These include a broad range of geographic distribution of MHK power generation for upstate rivers including the Black River, the Genesee River and the St. Lawrence, among many others.

- The NYS Canal System extends for 534 miles through the center of Upstate New York and is now largely underutilized as a transport system. Selected areas along the canal system can be well adapted to hydropower generation particularly around the higher speed sections of the locks. Energy revenues from appropriately installed MHK hydro systems can assist in defraying some of the economic burdens of the system due to the lack of commerce, low user fees and the maintenance impacts of the aging system.

- Shoreline and estuarine areas along the 1,850 of NYS coastal shoreline provide excellent opportunities for MHK installation. These include the demonstration area of NYC Harbor at Hell Gate and also many locations along the inlets of the south shore of Long Island and above all else The Race at the east end of Long Island Sound. NC estimates a 1,000 MW potential of tidal power from using less then 10 % of the tidal energy through The Race and the tidal flux around Shelter Island. Such a system would cost approximately $3.5 B and would generate 3.5 Million MWhrs, which is almost equivalent to the 3.8 Million MWhrs generated by renewable energy systems statewide in New York[4].

- The primary power systems-related advantage of MHK systems is that they provide base-load and highly predictable Renewable Energy Generation, unlike the load profile of wind or solar power. NC estimates an excess of 1,000 MW of potentially available tidal energy in NYS coastal shoreline areas alone. The proposed demonstration project can enable broad replication of the tidal energy system in this sector alone. The proposed project can clarify costs and present standard methods of site analysis, environmental impact as well as system technical and financial performance that can rapidly accelerate the permitting, social acceptance and investor understanding and acceptance.

Figure-2. Presents an overview of the project location in the heart of the New York City. The full scope of the project includes the installation of a Hybrid Renewable Energy System on NYC Parks property on the south shore of Wards Island, in a vacant area immediately adjacent to the shoreline. The immediate off shore location for a tidal turbine is facilitated by an ancient channel that funnels water speeds in access of 7 knots (3.5m/s) less than 50m from the shoreline (Figure-2). This is a remarkably good location for a tidal energy system and requires a minimal length of cable to an on-shore Electrical Room located in a prefabricated Interpretive Kiosk to house a project office and signage for public education of the Hybrid RE System operation for 5 kW Solar pV, 100 kW wind and 100 kW Tidal energy (Figure-3).

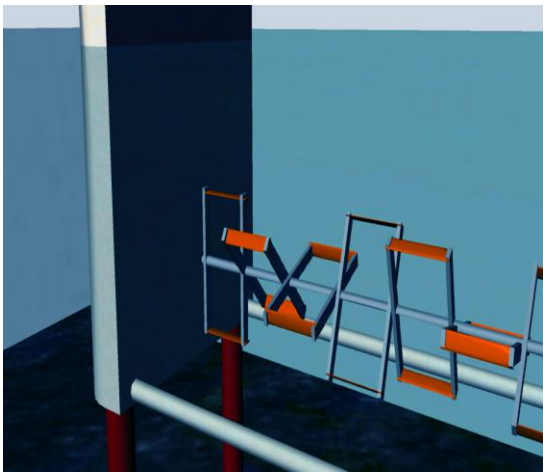

Figure-3. Detail of NC Sea Dragon.

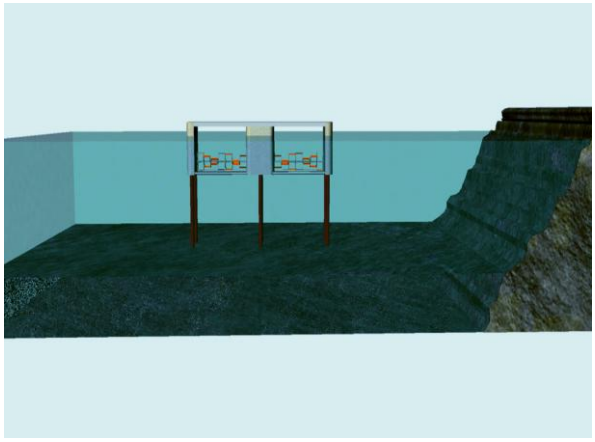

Figure-4. Scaled Drawing of NC Sea Dragon at Wards Island

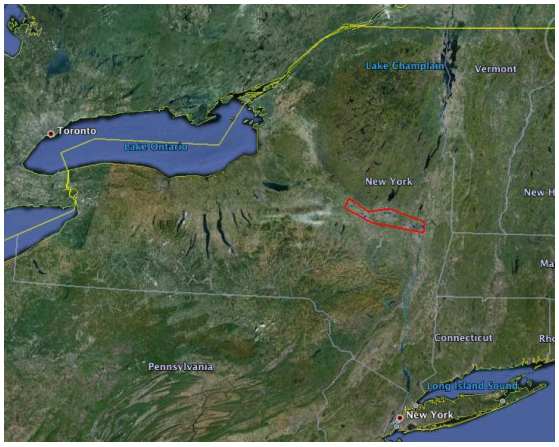

Figure-5. Site Map of Mohawk Valley

Figure-6. Site Map Fisher's Island

IV. Financial

Revenue Projections – 20 MW Installed in NYS

Site	MW Installed 2014	MW Installed 2015	MW Installed 2016	MW Installed 2017	MW Installed 2018
Fishers Island (CF=.4)	1	8	20	20	20
NYS Canal (CF = .8)	1	8	20	20	20
Revenue	$300 MW-hr				
Fishers Island	$1,051,200	$8,409,600	$21,024,000	$21,024,000	$21,024,000
NYS Canal	$2,102,400	$16,819,200	$42,048,000	$42,048,000	$42,048,000
Revenue	$150 MW-hr				
Fishers Island	$525,600	$4,204,800	$10,512,000	$10,512,000	$10,512,000
NYS Canal	$1,051,200	$8,409,600	$21,024,000	$21,024,000	$21,024,000

Financial projections for revenue are presented above. The capacity factor (CF) for power production for the Fishers Island Project is 40% or 0.4. The CF for the run of river aspect of the NYS Canal installation is 80% or 0.8. Total cost for system installation using the JEDI model described below is $4.72M per MW installed or $94.4M for the projected 20 MW installed altogether.

The Jobs and Economic Development Intuitive (JEDI) model was developed in conjunction with the National Energy Research Laboratory (NERL) and the Minnesota IMPLAN group to provide an economic impact forecast for renewable energy products. The nameplate production capacity was based on a 10MW build out. The total cost according to JEDI for 10MW would be 47.2 million dollars. The build out would then lead to 247 jobs in the state per every 10MW installed. Local spending would be 34.3 million during the 18-month construction period and the future total operating maintenance cost per a year is 3.4 million workers in New York State. This would lead to a significant amount of well paying sustainable jobs in New York State.

V. Permit Process

Regulatory Overview: The modern era of tidal and wave energy development is in its infancy. While technology development is advancing in some 20 nations around the world, the application of TISEC (Tidal In-Stream Energy Conversion) and WEC (Wave Energy Conversion) systems have few installed commercial scale systems by which to evaluate the regulatory process. Most projects are pilot and demonstration scale systems that form the basis for historical review of the regulatory process.

Approximately fifteen (15) federal, state, and local resource agencies have been identified to date that have some oversight and may evaluate potential tidal and wave energy projects with respect to potential environmental impacts or regulatory jurisdiction for permitting. An initial review of the responsibilities of each of these agencies has been conducted. Preliminary evaluations to date have requested a generalized view and understanding with respect to key concerns such as threatened and endangered species, navigational issues, impacts on sediments and benthos, public safety and among other issues.

Cooperative agencies for environmental impact assessments include*:*

US Army Corps of Engineers – US ACE
US Fish and Wildlife Service – US FWS
US Coast Guard – USCG
National Oceanic and Atmospheric Administration – NOAA
Federal Energy Regulatory Commission – FERC
National Marine Fisheries - NMF
New York State Department of Environmental Conservation – NYS DEC
New York State Department of State – NYS DOS per SEQR
New York State Coastal Management Program – NYS CMP
Local Community Planning Boards

FERC Authority on Tidal Energy Projects

Several key issues are emerging in the field of system permitting in the United States. Most critical at this time are developments within the Federal Energy Regulatory Commission.

Pursuant to Part I of the Federal Power Act of 1978 (FPA), FERC has authority to issue preliminary permits and licenses for the construction and operation of hydroelectric projects on navigable waters, public lands and reservations or which impact interstate commerce through interconnection to the electric grid or interstate commerce.

Currently FERC provides a 3-year window to complete related studies for companies developing given tidal or wave energy sites. These preliminary permits may be extended an additional 3 years making a total of six (6) years for system development and related environmental studies. Many view this process as so long as to deter private investment.

The time involved for permitting is further lengthened because many agencies do not yet have a knowledge base or precedent for reviewing this relatively new and emerging technology. A Preliminary FERC Permit gives companies incentive to take the risk of investing money to gather necessary data and

prepare a license application. The Preliminary FERC Permit guarantees the company an exclusive right to file a license application during the term of the permit and a first-filed priority over later filing competitors.

As of December, 2006 FERC is re-evaluating the criteria by which preliminary applications for tidal and wave energy sites are evaluated. It is expected that any changes in site permitting procedures will be published in early 2007. Some observers state that the overall problem is that the traditional FERC permitting approach stretches back almost 100 years and is no longer applicable to the emerging field of tidal and wave energy development. These issues are being reviewed by the Ocean Renewable Energy Coalition as well as many interested commercial interests in the emerging tidal and wave industry. The chart below provides a view of jurisdictional areas with impacts on tidal and wave energy development.

Additional Federal Oversight

Federal Power Act, 16 U.S.C. § 817 (1) - FERC Authority and Jurisdiction

The Federal Energy Regulatory Commission (FERC) statutory authority states "it shall be unlawful for any person…for the purpose of developing electric power, to construct, operate or maintain any dam, …reservoir or powerhouse or other works across navigable waters of the United States….except in accordance with a license …[issued by FERC]. FERC has also determined that a wave energy project is a hydro project with a "power house" over which it has jurisdiction. Likewise FERC has jurisdiction over tidal and ocean current power projects up to three miles off shore. In 2005, FERC created the "Verdant exemption" which allows developers to deploy wave and tidal projects on an experimental basis, for a limited time frame (the initial exemption was for 18 months) provided that developers do not impact commerce by selling power to the grid and deploy projects to gather data for licensing. FERC must also give "equal consideration" to environmental and energy concerns (Sec. 4(e) of FPA, 16 U.S.C.§ 797) and be "best adapted to a comprehensive plan for developing a waterway, for protecting fish and wildlife and for other beneficial uses such as recreation, irrigation, water supply "(Sec 10 (a) FPA, 16 U.S.C. § 803 a).

U.S. Army Corps of Engineers

Section 10 of the Rivers and Harbors Act of 1899 - 33 U.S.C. 403

Section 10 states that the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is prohibited; and it is unlawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, except on plans recommended by the Chief of Engineers. Also, it is unlawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers.

33 U.S.C. § 404 – Dredge and Fill Permit

A 404 permit (Section 404 "dredge and fill) permit from the Corps of Army Engineers may be required for FERC projects, but is only applicable up to the three (3) mile offshore limit. Structures that impact and are sited within navigable waterways are clearly the jurisdiction of the ACE. Projects involving such development must be reviewed by the ACE and permitted prior to installation as established by the Rivers and Harbors Act of 1890 and 1899.

US Coast Guard (USCG) Regulations

33 C.F.R. Part 62, 64, 66 Marine Navigation Lights

These regulations require and specify navigation lights must be posted on pilot, demonstration and commercial wave and tidal projects that may impact marine navigation and require that they be visible for one mile. The USCG would make a determination of requirements regarding the markings, lights and fog signals that would be appropriate for a given system deployment.

National Environmental Policy Act (NEPA)

42 U.S.C. § 4332 (c) Environmental Impact Statement

NEPA requires preparation of an Environmental Impact Statement (EIS) for "major federal actions significantly affecting the quality of the human environment." An environmental assessment (EA) must be prepared to determine if an EIS is necessary. Both the EA and the EIS must consider alternatives (build, no build, alternate location) and a variety of socio-economic, environmental and cultural impacts. The Federal Power Act allows licensees to retain "third party contractors" on agency's approved list to prepare the EA or the EIS.

Coastal Zone Management Act – (CZM)

16 U.S.C. § 1374 – CZM Consistency Finding

Coastal States with approved CZM plans must issue a "consistency finding" that confirms that the proposed project is consistent with the state's CZM Plan. The Secretary of Commerce can consider whether to overrule the state's inconsistency finding if the applicant seeks review. The FERC license will not be issued without a consistency finding. **Coastal Zone Management Act (CZMA) of 1972** will involve three additional agencies that include (1) US Fish and Wildlife Service – US FWS, (2) National Oceanic and Atmospheric Administration – NOAA, and (3) National Marine Fisheries - NMF

National Historic Preservation Act

16 U.S.C. § 470 Protection of Historic Resources

If it is determined that there is a possible impact on historic resources, an evaluation of the project's potential impact on these resources must be completed in consultation with the state historic preservation agencies.

Fish and Wildlife Coordination Act

16 U.S.C. § 661 Fish and Wildlife Impacts

This act requires consultation with federal and state fish and wildlife agencies where a federal project impacts a body of water. FERC has its own independent consultation requirements under Section 10 (I) of the Federal Power Act.

Endangered Species Act (ESA)

16 U.S.C. § 1531 Endangered Species Impact

Section 7 of the ESA requires consultation with the Secretary of the Interior prior to project development to determine if endangered species may be present or adversely impacted by the project development.

Marine Mammals Protection Act

16 U.S.C. § 1361 – 1407 Harassment of Endangered Mammals

This federal law prohibits the harassment, hunting or capture of depleted endangered marine mammals. The project must prove that it does not "harass" protected marine mammals.

Submerged Land Act

43 U.S.C. § 1301 – Lease for Use of State Lands

The application of this law depends on the project location. At a minimum, the land lease would be required for transmission lines to shore. Also, under the FPA, 16 U.S.C. § 814, licensee has the power of eminent domain, which could possibly be used to acquire state lands. It should also be noted that eminent domain authority has never been tested for in such an application.

Production Tax Credits

Section 45 IRS Code Renewable Energy Production Incentive (REPI)

The REPI would apply for tidal and wave energy projects and is structured such that municipal entities may receive cash reimbursements from the federal government for capital projects which include production of power from renewable energy sources.

VI. Other Considerations

- Regulatory reform has begun in the field of Marine Hydro Kinetic technology with progressive action by the US ACE and reforms of the NEPA process.

- These reforms have served to reduce the time to process the necessary permits and enable a Nationwide Permitting Process to proceed.

- NYS should support this process with the following actions:

    - Form a State Wide Task Force for MHK Regulatory Reform.

    - Recommend Actions that streamline permitting and adjust requirements to National Standards set by the US ACE, FERC, NMFS.

    - Establish a NYS wide monitoring program of environmental factors based on international recommendations for assessing marine / aquatic impacts.

    - Establish a State Wide Database required of all projects to catalogue, assess and compare environmental impacts from statewide monitoring.

- Establish a seven-year (7-year) incentive program to support the price of Tidal Generated Power in New York State at $300 per MW-hour. This compares favorably but does not exceed the price supports via Feed In Tarrifs (FITs) in Nova Scotia ($624 USD / MW-hr), the United Kingdom ($420 USD / MW-hr), and India (50% of the Costs of MHK projects supported by India Government).

- After 7 years the price of MHK power should be allowed to float with existing market conditions and statewide competition.

VII. Additional Information

1. **Property Mohawk Valley MHK Energy Project.** In 1992, the New York State Barge Canal was renamed the New York State Canal System (including the Erie, Cayuga-Seneca, Oswego, and Champlain canals) and placed under the newly created New York State Canal Corporation, a subsidiary of the New York State Thruway Authority. The Canal System is operated using money generated by Thruway tolls. A total of six (6) central NYS Counties border the proposed project location, including Herkimer, Fulton, Montgomery, Saratoga, Schenectady and Albany Counties.

2. **Property Fishers Island Tidal Energy Project.** The project location is located entirely within Suffolk County, Long Island, New York. The project can foster regional cooperation with the State of Connecticut and provide power to the NEPOOL.

3. **Projected In-Service Date.** Permitting can commence with a 24-month lead-time under the best of circumstances. USACE permits for Nation Wide Permitting of up to 10 MHK units (1 MW) will be the keystone of early stage development. Under favorable conditions of public outreach and acceptance, first units installed in late 2014. Build out of the project scope can be completed during 2015-2016. Detailed scheduling is presented in the FERC Preliminary Permit Applications

that has been submitted for both these locations by Natural Currents Energy Services, LLC in early 2012.

4. **Interconnection. Fishers Island Tidal Energy Project** interconnection points can be most easily achieved through a 3-mile cable to the New London area of Connecticut. Cables already exist in this area. Alternatively a longer cable connection can be made to Orient Point to connect with a 17kV line maintained by LIPA. **Mohawk Valley MHK Project** has many possible connection points along the six county span of 14 potential installations along the NYS Canal System between Little Falls and Albany.

5. **Base load Renewable Energy.** Investor owned utilities are responsible for compliance with the RPS standards in NYS. These organizations can benefit through a greater knowledge of how tidal energy systems can work in NYS and assist in the process of meeting the RPS goals that we all share. The project will demonstrate both distributed generation of innovative new hydropower systems an provide base-load renewable energy that is completely predictable. Predictability is the life-blood of electric utilities. Tidal energy production can be predicted for centuries into the future with great reliability. This is an important factor for public utilities.

6. **Technical.** All key components (shaft, rotors, generator) are rated for 20 years lifetime. Biannual field maintenance program will enable optimal performance. The Natural Currents Sea Dragon system is vessel-mounted that enables significant flexibility for system installation. For marinas this enables replacement of seasonal rental slips with year round revenue from tidal energy systems. New models can be effectively replaced. Equipment can be easily adjusted to Seasonal variations in tidal flow regimes. System maintenance is facilitated by having the generator system enclosed within a dry “machine room” in the central hull of the vessel-based system. Monitoring equipment is installed on the vessel that makes for easier data collection and transmission. Fish sampling is facilitated as the vessel has a deck from which to work. Workboats have a structure to tie onto during periods of research vessel sampling. Titanium components provide for a 20-year life span of equipment. Elastomeric Polymer Bearings have already demonstrated a 20-year life on hydro projects in Canada, having been used since 1966 in gritty, sediment-laden environments. The NC Sea Dragon system promises long performance, easy maintenance and lower costs once mass production manufacture can begin at a later stage.

7. **Construction and Manufacturing Location**. The tidal energy system will be manufactured in Kingston, New York at the FALA precision engineering company. This company has manufactured and tested cross flow wind technology. It has the precision engineering skills and experience needed to complete the tasks for system assembly. FALA has worked with the types of processes and metals, particularly titanium required for the tidal energy system design. **Labor.** Green-Jobs development program will enable skill set growth and re-training to provide for the complete spectrum of needed positions. Downstream supply chain can be supplied in New York State and region. **Decommissioning.** Vessel-mounted systems enable easy movement and decommissioning. Replacement systems with evolving and new technology easily substituted during programmed maintenance cycles. Old systems may be sold in after market and re-conditioned for developing regions and countries.

8. **Operations, Technology Transfer and Replication.** After initial project installations, the target audience is broad for project replication. A key early adopter market that has emerged consists of marina owners who have “high speed slips” with strong tidal flows. These slips are difficult for weekend mariners to maneuver and generally rent for less than more favorable locations. These slips can be used for fixed or vessel mounted NC tidal energy systems. Projects are underway at

several marinas in New Jersey. The owners are limited to a 5 to 6 month seasonal income from slip rentals can now consider secondary income from net metered or Power Purchase Agreement electricity sales. This market is extensive on both a national and international level. Municipalities with shoreline, estuarine or river-based properties can also significantly benefit from the development of tidal energy at appropriate sites.

9. **Socio-Economic - Estimated New York Commercial Market**. The estimated commercial market for New York State is a minimum of 1,000 MW of installed capacity of these systems or a minimum total of 10,000 system during the next 20 years. The estimated cost of system installation averaged for larger projects is $3.5M per MW installed. Therefore the estimated NYS commercial market is $3.5B over the next 20 years for locations in upstate rivers, along the NYS canal system and in near shore inlets and high tidal flux areas in New York Harbor and Long Island.

10. **Socio-Economic - Potential Application at Other Sites.** There is a high potential for application of this technology at other sites as described above. The proposed demonstration site will facilitate such applications by enabling a very visible demonstration site in the heart of New York City to provide a broad range of needed monitoring data for analysis, public information and system improvement. These include feedback on the ware characteristics of system component parts over a five (5) year period. Environmental impacts are a key concern of regulatory agencies. All major environmental impact parameters of international inquiry are assessed by the proposed project[6]. The evaluations made during this project can serve to streamline the permitting process by providing incontrovertible and definitive data and proof of the benign impact of tidal energy systems on the marine ecology. Power output and financial revenue data will be presented to potential investors. The nascent but world-wide ocean renewable energy industry will greatly value the monitoring of the system installed at this site. Natural Currents is presently dealing with both the US Navy and the Royal Navy (UK) on an introductory level to provide initial information about the value of vessel-mounted tidal energy systems. Rapid deployment of tidal based electric power after natural disasters may find greater use for future intervention after natural disasters such as floods, earthquakes and tsunamis. New York State application of this technology to other sites will be fostered through active public relations, presentations at conferences and extensive use of social media networking now used by Natural Currents Energy Services, LLC.

11. **Regulatory Issues - Barriers to Market Entry.** The barriers to market entry include primarily three (3) factors. These include (1) regulatory hurdles, (2) public understanding and acceptance and (3) lack of private sector investment. The proposed demonstration site will effectively improve social acceptance and understanding of environmental impacts that will serve to reduce regulatory barriers that now require excessive monitoring and time that is very costly at this stage of industry development. Private sector investors will be encouraged by the finding of limited, if any, negative environmental impacts and the overall profitability due to lower maintenance and higher, base-load renewable energy generation.

12. **Public Outreach.** Natural Currents has presented papers and lectures at significant renewable and marine industry conferences including the Small Hydro Conference sponsored by the UK group Green Power Conferences that was held in Washington, DC in December 2010 and the UN Conference on Global Climate Change in Copenhagen, Denmark in 2009. Natural Currents has further been invited to present a keynote address at the Small Hydro Conference in Sao Paulo, Brazil in May 2011. Natural Currents has been a presenter at the Nortek USA conference in

Newport Beach, RI in 2011 attended by primarily Marine monitoring equipment manufacturers and regulatory agencies. Natural Currents has enabled television interviews on Tidal Energy with Channel 12 News NJ, NBS News New York in 2010, Lang and O'Leary Financial News for a Canadian TV Station, Planet Forward interviews which is part of PBS and also several radio programs on tidal energy including a business profile on American Express Radio program and radio stations in Boston, New York, New Jersey and California. New York State conferences will become a point of focus to effectively network project findings in New York State. Regulatory requirements for public meetings will further engage the public and enable enhanced understanding of system impacts, controls, monitoring and benefit.

13. Energy Benefits

- Energy benefits include generation of 82,000 MW hours of electric power annually.
- Completely predictable energy production from known tidal cycles.

14. Environment Benefits

- Direct impacts include the reduction of 155,224 pounds of Nitrogen Oxides per year.
- Benefits include reduction of 310.48 pounds of Sulfur Dioxides per year.
- Direct benefits include the reduction of 56,720 Tons of Carbon Dioxide per year.

15. Other Benefits.

- Potential to streamline permitting process for similar projects due to long term monitoring
- Improved understanding and knowledge of minimal environmental impacts.
- Development of standard protocols for system installation, monitoring and design
- Potential for broad scale commercialization of tidal technology
- Manufacturing of tidal energy systems at New York Based Precision Engineering Company

16. Economic Analysis

Marine Hydro Kinetic (MHK) Jobs and Economic Development Intuitive (JEDI) for New York State

To understand the potential economic impact of Marine Hydro Kinetic (MHK) renewable energy in the United States the National Energy Research Laboratory (NREL) has developed a system that is called the Jobs and Economic Development Impact (JEDI) model. The model uses the state specific data files and economic multipliers from the Minnesota IMPLAN group accounting software for economic forecasts. The factors that IMPLAN uses were gathered through extensive research and analysis of current industry standards and through interviewing industry professionals.

This JEDI Model for a potential MHK technology project such as installations on the NYS Barge Canal (the modern version of the old Erie Canal) has been run using New York State data with the inputs highlighted in green. The assumptions that were made with respect to the manufacturing and development jobs are highlighted in yellow. All other data is from the IMPLAN data and cannot be changed in the JEDI model. MW nameplate capacity is 10 MW so for smaller sizes we will assume that division of numbers by said factor will be accurate. The rate of $/kW is a cost that is derived from the IMPLAN databases on calculations and research.

Marine and Hydrokinetic - Project Data Summary based on model default values			
Project Location		New York	
Year of Construction or Installation		2013	
Reference System Size - Nameplate Capacity (MW)		10.0	
Total Project Size - Nameplate Capacity (MW)		10.0	
Construction Period (months)		18	
System Type		Tidal Power	
System Cost ($/KW) or ($4.724M per MW installed)		$4,724	
Annualized O & M Cost (percent of Capital Cost)		7.3%	
Money Value (Dollar Year)		2012	
Project Construction or Installation Cost		$47.2M	
Local Spending		$34.3M	
Total Annual Operational Expenses		$10.1M	
Direct Operating and Maintenance Costs		$3.4M	
Local Spending		$2.7M	
Other Annual Costs		$6.8M	
Local Spending		$0.1M	
Debt Payments		$0.0M	
Property Taxes		$0.0M	
Sales Tax		$0.1M	
	Jobs		**Earnings**
Local Economic Impacts - Summary Results	Jobs / Year	**$MM (2012)**	**Output**
During construction and installation period	17.0	$2.2	**$MM (2012)**
Project Development and Onsite Labor Impacts	8.1	$1.1	$3.3
Construction and Installation Labor	9.0	$1.1	
Construction and Installation Related Services	150.1	$12.4	
Module and Supply Chain Impacts	56.0	$4.0	$41.9
Induced Impacts	**223.1**	**$18.5**	$10.3
Total Impacts	**223.1**	**$18.5**	**$55.5**
	Annual	**Earnings**	**Annual**
	Jobs	**$MM (2012)**	**Output**
During operating years			**$MM (2012)**
Onsite Labor Impacts	9.5	$0.7	
Hydro Project Labor Only	9.7	$0.9	$0.7
Local Revenue and Supply Chain Impacts	4.7	$0.3	$2.9
Induced Impacts	**23.8**	**$2.0**	$0.9
Total Impacts	**23.8**	**$2.0**	**$4.5**

*Notes: Earnings and Output values are millions of dollars in year 2012 dollars. Construction period related jobs are full time equivalent jobs for one year. Based on the 18 month construction period this is an annual average of approximately 149 full time equivalent jobs. Hydro project labor includes all onsite operators and technicians as well as administration and management. The analysis does not include impacts associated with plant "profits" and assumes no tax abatement unless noted. Totals may not add up due to independent rounding. Due to the many uncertainties surrounding these new and emerging technologies all impacts should be viewed as preliminary and caution applied when reporting results.

Detailed Hydro Project Data Costs		**Local**	
	Cost	**Share (%)**	
Installation Costs			
Materials & Equipment	$31.1	75%	
Device	$4.7	50%	
Underwater Electrical Collector System	$0.5	50%	
Underwater Transmission Cable	$1.1	50%	
Cable Landing and Grid Interconnection	$2.0	75%	
Balance of Plant	$39.3		
Subtotal			
Installation/Labor	$2.5	75%	
Mooring and Device Installation	$1.0	75%	
Underwater Cable Installation	$0.5	75%	
Cable Landing and Grid Connection	$4.0		
Subtotal	**$2.4**		
Permitting Cost	**$45.7**		
Subtotal	$1.6	100%	
Sales Tax (Materials & Equipment Purchases)	$47.2		
Total	$47.2		

Annualized Operating and Maintenance Costs	**$MM (2012)**	**Local**	
		Share (%)	
	$0.8	100%	
Labor	$2.6	75%	
Materials and Services	$3.4		
Subtotal	$0.1	100%	
Sales Tax (Materials & Equipment Purchases)	$0.9	0%	
Average Annual Debt Payment (Interest and Principal)	$0.0	0%	

Equity Payment - Individuals	$5.8	0%	
Equity Payment - Corporate	$0.0	100%	
Property Taxes	$0.0	100%	
Lease Cost	$10.1		
Total			
Other Parameters		**Local**	
		Share (%)	
Financial Parameters			
Debt Financing	20%	0%	
Percentage financed	20		
Years financed (term)	10%		
Interest rate			
Tax Parameters	0%		
Local Property Tax (percent of taxable value)	100%		
Assessed Value (percent of construction cost)	100%		
Taxable Value (percent of assessed value)	$45.7		
Taxable Value (million$ - if applicable)	100.0%		
Property Tax Exemption (percent of local taxes)	$0.0	100%	
Local Property Taxes	4.0%	100%	
Local Sales Tax Rate	$0.0	100%	
Lease Cost (if applicable)			

*** Spreadsheet is taken from JEDI software output**

Impacts in New York State - Assumptions

- Tidal Turbine Has a .4 Capacity Factor
- Turbines run for 365 days a year 24 hours a day
- Project Sourcing is Highlighted above in Yellow
- $300 MWhr Incentive

MW Size	Cost per MW	Jobs Created per 1 MW	Cost for Build Out	Total Jobs Created	kWhr Produced	MWhr Incentive	Annual Revenues	SPB Years
1	$4,723,968	25	$4,723,968	25	3,504,000	$300	$1,051,200	4.49
5	$4,723,968	25	$23,619,840	123	17,520,000	$300	$5,256,000	4.49
10	$4,723,968	25	$47,239,680	247	35,040,000	$300	$10,512,000	4.49

Summary. By implementing an incentive of $300 MWhr we are able to reach our goal of a 5-year simple pay back (SBP). This is an important goal for new technologies and it is imperative that such policies be enacted to foster economic growth and technology development. This SBP allows for more investment into the industry that will lead to further economic and social benefits.

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